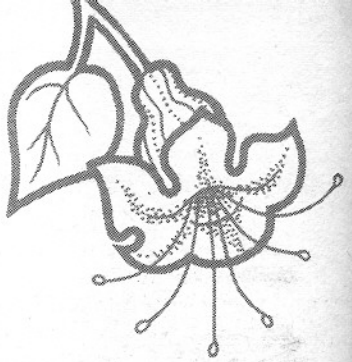


SOIL MOISTURE MONITOR

BY A.R.WINSTANLEY

THOSE of us with green fingers know exactly when to water potted plants, and how much water to pour on without drowning the plant.

This device has partly a novelty value, but also definitely does give some indication of when the soil that it is measuring is "wet" or "dry". It may therefore help to give more consistent and successful results, assisting those who don't have much luck with potted plants.

The unit comprises a small case with two "probes" protruding outwards. The probes are pushed into the pot-plant soil and a push button is pressed. One of two lamps, one red and the other green, will then illuminate to indicate if the soil is dry or wet respectively.

One advantage is that this unit does actually measure the soil several inches below the surface; this is obviously better than just going on the appearance of the soil surface alone.

CIRCUIT DESCRIPTION

Only seven electronic components, plus a battery and switch, are required in this simple design and the full circuit is shown in Fig. 1. Most of the work is done by IC1, a cheap and readily available 741C op-amp.

This has two inputs. Pin 2 has the negative symbol and is called the inverting input, pin 3 is the non-inverting input and is marked with a positive sign.

The variable resistor VR1, is wired between the supply lines and its wiper is connected to the inverting input. The setting of VR1 therefore determines the voltage at pin 2, and this can be altered from +9V to 0V.

At the non-inverting input we have the same sort of thing. The two probes, when inserted into soil, in effect form a resistor. The value of this "resistor" is dependent upon the moisture within the soil: the more moisture there is, the lower the value of this resistance.

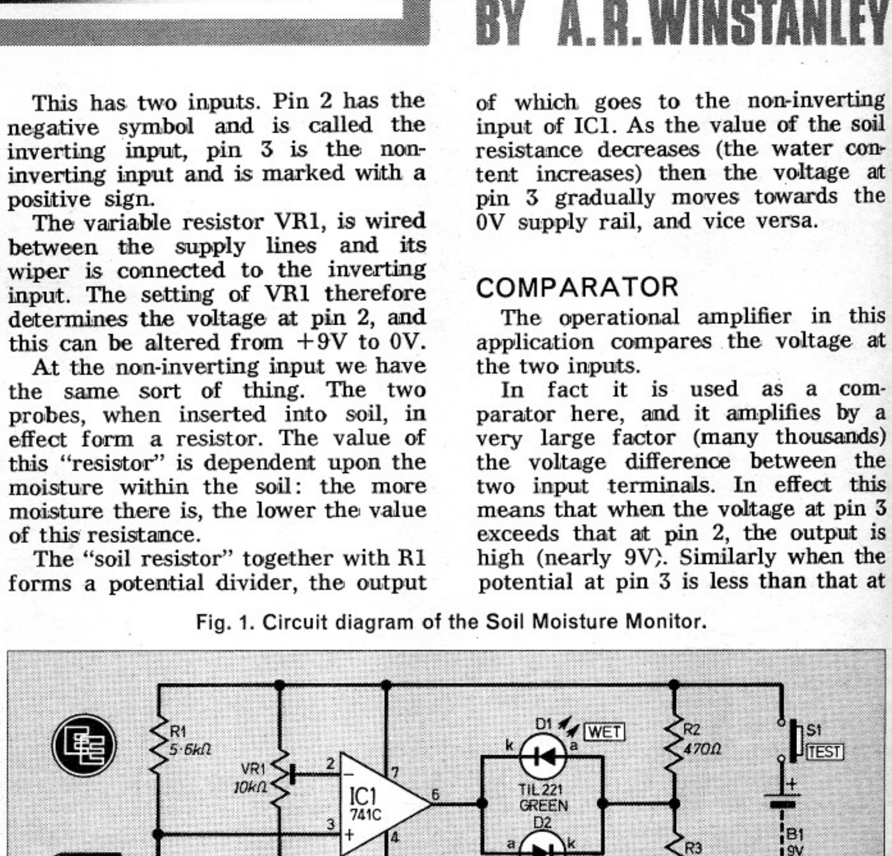
The "soil resistor" together with R1 forms a potential divider, the output of which goes to the non-inverting input of IC1. As the value of the soil resistance decreases (the water content increases) then the voltage at pin 3 gradually moves towards the 0V supply rail, and vice versa.

COMPARATOR

The operational amplifier in this application compares the voltage at the two inputs.

In fact it is used as a comparator here, and it amplifies by a very large factor (many thousands) the voltage difference between the two input terminals. In effect this means that when the voltage at pin 3 exceeds that at pin 2, the output is high (nearly 9V). Similarly when the potential at pin 3 is less than that at

Fig. 1. Circuit diagram of the Soil Moisture Monitor.



pin 2, the output is low, approximately 0·5V.

Assuming that VR1 is at mid-position, when the soil is wet, we can say that the voltage at pin 3 will be lower than at pin 2. Therefore the output of IC1 is low. Current can therefore flow through R2 and D1, and "sink" into the output pin causing the green l.e.d. to light up. This is labelled WET.

Similarly with dry soil, the high resistance of the soil ensures that pin 3 is at a greater voltage than pin 2. The output pin therefore swings high, and it allows current to flow through the red l.e.d. D2 and R3 to 0V lighting up the diode. This is labelled DRY.

Only one l.e.d. can glow at a time: when one l.e.d. is forward-biased (therefore illuminated) the other l.e.d. is reverse-biased and cannot light up.

By adjusting VR1, the switching point of the op-amp can be controlled. This effectively means that you can alter the unit to signal WET or DRY at your own desired levels of moisture content. This can be worked out over a period of time.

The circuit operates from a 9V PP3 battery. Power is only applied when S1 is pressed to take a reading, and so battery life should be long.

CIRCUIT BOARD

Assembly of this unit is relatively simple, although to the absolute novice it may be just a little fiddly. This is because the components are soldered on a rather small piece of 0·1 inch pitch stripboard measuring 6 strips × 18 holes.

The component layout is shown in Fig. 2. There are seven breaks to be made in the copper strips and these should be made before assembly starts. For IC1 use an 8-pin d.i.l. socket so that the i.c. will not be damaged by overheating during soldering. The order of assembly is not important but joints should be firm and bright.

A Bimbox type BIM2002/12 houses the unit. This handy-sized box measures 100×50×25mm. The stripboard then slots into vertical p.c.b. guides moulded into the interior of the case.

Any other plastic case can be used, although it may be necessary to find some other means of fixing down the stripboard. For example, a longer piece could be used, the excess being drilled to take standard mounting hardware and spacers.

FINISHING OFF

The case should next be drilled and off-board components mounted in position. Flying leads made of flexible stranded wire should be connected in accordance with Fig. 2.

It is important that the case is drilled such that there is room inside for the battery and switch once the stripboard and l.e.d.s have been positioned.

The two probes are made of 4BA threaded brass rod about 120mm long. Connections to the probes are made by solder tags placed under the mounting nuts within the case.

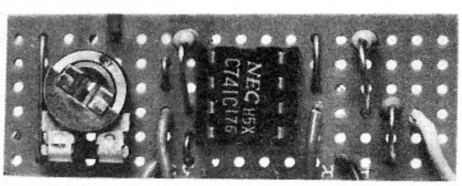
The two light-emitting diodes can be secured in position with either an appropriately-coloured lens-clip or a standard plastic fixing clip.

Finally the battery can be held in place with double-sided tape or a small adhesive foam pad.

SETTING UP

With construction completed, set VR1 to approximately midway, connect up a battery and press S1. The red l.e.d. should glow. Bend the two probes together at their tips so that they short together: the red lamp should extinguish and the green l.e.d. illuminate.

If this happens the unit is ready to use. Set VR1 to give the desired switchover point of the two indicators. Here it may prove useful if you have some small containers of soil available. The individual samples should have various levels of water content, ranging from dry to saturated. It should then be possible to eventually adjust VR1 until a desired sensitivity is obtained. ⌑



Close up view of the components in place on the circuit board.

Interior of the case. Note the solder tag connections to the probes.

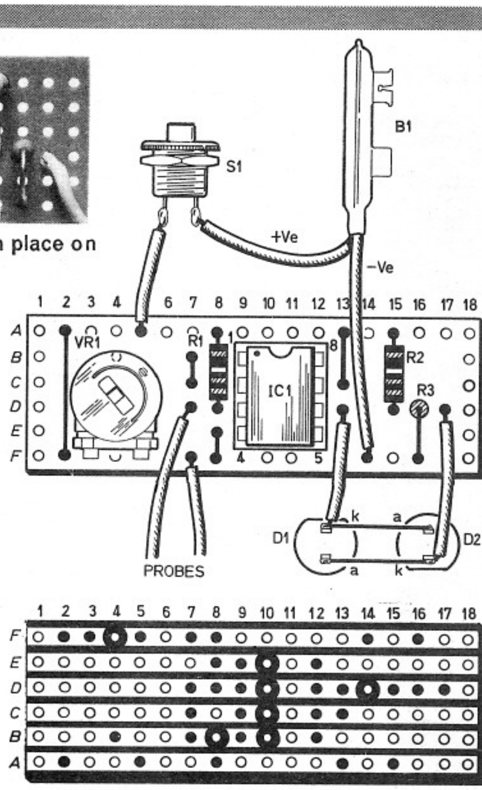


Fig. 2. Stripboard layout and interwiring diagram.

COMPONENTS

Resistors
R1 5·6kΩ
R2 470Ω
R3 680Ω
All ¼W carbon ±5%

See **Shop Talk** page 705

Semiconductors
IC1 741C 8-pin d.i.l. operational amplifier
D1 TIL221 0·2 inch green l.e.d.
D2 TIL220 0·2 inch red l.e.d.

Miscellaneous
VR1 10kΩ miniature horizontal skeleton preset.
S1 single-pole push-to-make, release-to-break
B1 9V type PP3
0·1 inch matrix stripboard: 18 holes by 6 strips; case, 100 × 50 × 25mm, Bimbox BIM2002/1 or similar; battery connector; 4BA fittings, threaded brass rod for probes; 8 pin d.i.l. socket; connecting wire; mounting clips for D1 and D2.

Guidance only Approx. cost £5 excluding case